Docket No.: S3-02P19752

CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of the International Patent Application PCT/DE2003/003669, filed 5 November 2003 and of the amended claims, filed 21 July 2004.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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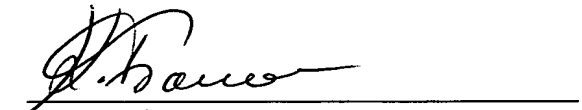

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Description

Method for producing high-pressure fuel accumulators

The invention relates to a high-pressure fuel accumulator for a fuel injection system of an internal combustion engine, comprising a tubular base body, a plurality of connections and at least one fixing element, whereby the tubular base body is embodied as a single component with the connections and the fixing element.

A high-pressure fuel accumulator for a fuel injection system of an internal combustion engine is known from DE 197 20 913 C1, comprising a tubular base body and at least one connection for the fuel supply and the fuel discharge. In this situation however, the base body consists of a first tubular element and a second element arranged in the interior of the first tubular element.

A high-pressure fuel accumulator is known from DE 295 21 402 U1 which is formed as a tubular base body by forging, with connections and fixing elements likewise formed as a single component by forging. For each engine variant, the connections and also the fixing elements are formed to fit precisely on the tubular base body in each case, as a result of which a different forging blank is required in each case for each engine variant. This results in very high unit costs with regard to small-scale series production in particular.

In order to reduce the costs for such types of forged high-pressure fuel accumulators, DE 199 36 534 A1 proposes a method

whereby the tubular base body is formed with a continuous connector strip. The connections can be incorporated in the continuous connector strip as required by drilling. The fixing elements are either clamped or welded onto the tubular base body by means of fixing lugs. However, the clamped fixing lugs have an additional space requirement and can come loose in time. With regard to the welded fixing lugs, as a result of the welding operation a certain distance must be maintained between the individual fixing lugs when applying the welding seams. This can have the result that in the case of extremely compact fuel distribution systems the construction size of the distribution system is largely predetermined by the fixing lugs.

Furthermore, all forged fuel distribution systems have the disadvantage that the pressure reservoir must be produced by means of a costly and complicated deep hole drilling process in the forging base body.

The object of the invention is to provide a simple and cost-effective method for producing a high-pressure fuel accumulator.

This object is achieved by features of the independent claim. Advantageous embodiments of the invention are set down in the subclaims.

The invention is characterized in that a hollow profile of the tubular base body is profile-extruded with at least one connector strip and/or one fixing strip. The profile extrusion presses offer the advantage that the high-pressure fuel accumulator can be individually adapted in a simple manner to suit the engine conditions. The hollow profile initially

leaves the profile extrusion press in the form of a long profile blank. A plurality of high-pressure fuel accumulators can be produced from one profile blank. To this end, the profile blank is divided into a plurality of pieces. Each individual piece is separated from the profile blank in such a way that it actually has the desired length. Since a hollow profile is actually formed by the profile extrusion presses, the costly and complicated deep hole drilling process which is otherwise needed is not required.

The connections can be incorporated into the connector strip formed as a single component with the base body at almost any desired spacing from one another. The connections are preferably incorporated by means of drilling. The minimum spacing between the individual connections is restricted only by the component strength, in other words only a minimum wall thickness between the individual connections needs to be maintained. By this means, the connections can be adapted individually and cost-effectively to the individual engine variants. The fixing drill hole is incorporated into the fixing strip in the same manner. The method thus makes it possible to produce extremely compact high-pressure fuel accumulators.

The method likewise allows changes to the profile to be implemented quickly and inexpensively since it is simply necessary to exchange the extruding die for different profiles. This is very favorably priced on account of its simple structure.

The proposed high-pressure fuel accumulator can thus be produced in a significantly simpler and more cost effective manner when compared with the previous solutions. The method

means that it is possible to implement favorably priced high-pressure fuel accumulators particularly also for small-scale series production or prototypes.

In a particularly advantageous embodiment of the invention, after the connection hole has been incorporated into the connector strip or after the fixing holes have been incorporated into the fixing strip the superfluous material between the individual holes is removed from the corresponding strips by means of a separating method. As a result, individual connecting pieces or fixing elements are produced in place of the strips. A particularly weight-optimized high-pressure fuel accumulator is obtained by removing the superfluous material. All known separating methods are suitable for removing the superfluous material; machining methods such as milling or planning are particularly advantageous.

A further preferred embodiment of the invention makes provision for additionally hardening the surface of the high-pressure fuel accumulator by means of cold working. Cold working can be achieved for example by redrawing the tube profile through a slightly smaller extruding die.

Embodiments of the invention will be described in the following with reference to the schematic drawings. In the drawings:

Figure 1 shows a longitudinal section through a high-pressure fuel accumulator, having two connector strips and also one fixing strip,

Figure 2 shows a cross-section through the same high-pressure

fuel accumulator, and

Figure 3 shows a high-pressure fuel accumulator in which the superfluous material between the individual connection holes has been removed from the connector strips by means of a separating method.

Figure 1 shows a longitudinal section through the high-pressure fuel accumulator. The high-pressure fuel accumulator 1 comprises a tubular base body 2 having a first connector strip 5, a second connector strip 6 and also a fixing strip 7, which are formed as a single component with the tubular base body. In addition, the high-pressure fuel accumulator 1 has a longitudinal hole 13 which forms the high-pressure fuel accumulator. A first connection 3 which serves to supply the high-pressure fuel accumulator 1 with fuel is incorporated into the first connector strip 5. A second and a third connection 4 which are connected to the injection valves by way of lines that are not shown are incorporated into the second connector strip 6. The fixing strip 7 has fixing holes 8. The fixing holes preferably take the form of a through-hole and serve to receive fixing screws with which the high-pressure fuel accumulator 1 is fixed to the internal combustion engine. The connections 3, 4 and also the through-holes 8 are preferably produced by drilling.

Figure 2 shows a cross-section through the high-pressure fuel accumulator 1 described with reference to Figure 1. The cross-sectional profile with the longitudinal hole 13 is produced using extrusion presses. With regard to the extrusion presses, a metal block heated to the press temperature is introduced into a cylindrical receiving tube in the press and is pressed by means of a stamp pressure through a die provided with the

desired profile. In order to produce the hollow profile, during the extrusion process the block is perforated beforehand and the metal is pressed by means of a mandrel located on the press stamp through the space remaining between the die opening and the mandrel. After the extrusion process, only the connections 3, 4 and also the fixing holes 8 then need to be introduced in the high-pressure fuel accumulator 1 and the open ends of the longitudinal hole 13 need to be sealed by means of suitable plugs which are not shown. The number, position and form of the connections are naturally not restricted to the embodiment. The maximum number of connections is given by the diameter of the connections and the minimum required wall thickness between the individual connections. The connections do not, as shown in the embodiment, need to enter the longitudinal hole 13 radially but can also run tangentially to the longitudinal hole 13, for example. Deviations from a circular cross-section for the connections are also possible, such as elliptical cross-sections for example.

In order to minimize the weight of the high-pressure fuel accumulator 1 it is particularly advantageous to remove the superfluous material from the connector strips 5, 6 between the connection holes 3, 4 and also from the fixing strip 7 between the individual fixing holes 8 by means of a separating method. Figure 3 shows a high-pressure fuel accumulator 1 in which the superfluous material has been removed from the connector strips 5, 6. This means that only three connecting pieces 9, 14 and 15 result instead of the first and second connector strips 5, 6. In this manner the weight of the high-pressure fuel accumulator 1 can be considerably reduced without reducing the strength of the component. A suitable separating method is preferably a milling method, by which

means the removal of the superfluous material can take place in a very simple and cost-effective manner.

The proposed method is thus suitable in a very cost-effective manner for developing a high-pressure fuel accumulator comprising a tubular base body with connector strips formed as a single component and at least one fixing strip. The position of the connections can be freely selected as desired along the connector strips. In this situation, the connections can be incorporated at very close spacing from one another. Likewise, the fixing holes can be arranged at very close spacing from one another. The superfluous material can be removed from the high-pressure fuel accumulator by means of a separating method, as a result of which a weight minimization can be achieved for the high-pressure fuel accumulator.